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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

SARKAR, ASOK K

ART UNIT

PAPER NUMBER

2891

DATE MAILED: 07/28/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/796,442	Applicant(s) SWIHART ET AL.	
	Examiner Asok K. Sarkar	Art Unit 2891	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 09 March 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-36 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-36 is/are rejected.
- 7) ☒ Claim(s) 35 and 36 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 09 March 2004 is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>8/2/2004</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Objections

1. Claims 35 and 36 are objected to because of the following informalities: In claim 35, line 6, following the word "conditions", the word "effect" should be deleted. In claim 36, line 6, following the word "conditions", the word "effect" in line 7 should be deleted. Also, in these claims "an Si – H or OH" should be written as "a Si – H or OH ". Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

3. Claims 1 – 25 and 27 – 34 are rejected under 35 U.S.C. 102(a) as being anticipated by Li, "Photothermal Aerosol Synthesis OF And Photoluminescence From Silicon Nanoparticles," Paper Presented at Annual meeting, American Institute Of Chemical Engineers," p 1284 (2002).

Limitations of these claims regarding the precursor gas, sheath gas, photosensitizer, CO₂ Laser, etching acids and concentrations, oxidizer and concentrations, particle size, solvents, filtering of particles and type of filters are thoroughly described throughout the published article.

Claim Rejections - 35 USC § 103

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4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

7. Claims 1 – 3, 6, 7, 12 – 16 and 27 – 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Botti, "Photoluminescence From Silicon Nanoparticles Synthesized By Laser – Induced Decomposition Of Silane," J. Appl. Phys., Vol. 88 (6), p 3396 (2000) in view of Seraphin, "Influence Of Nanostructure Size On The

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Luminescence Behavior Of Silicon Nanoparticles Thin Films," J. Mater. Res., Vol. 12 (12), p 3386 (1997).

Regarding claims 1 – 3, 6, 7, 14 and 27 – 29, Botti teaches a process for producing photoluminescent silicon nanoparticles comprising:

- thermally decomposing a silicon precursor comprising silane SiH_4 in the presence of a sheath gas helium with CO_2 laser radiation under conditions effective to produce silicon nanoparticles in the abstract of the article in page 3396.

Botti fails to teach acid etching the silicon nanoparticles with a hydrofluoric acid and nitric acid solution under conditions effective to produce photoluminescent silicon nanoparticles.

Seraphin teaches that acid etching of silicon nanoparticles with a hydrofluoric acid and nitric acid solution can be used for the benefit of shifting the luminescent peak in the abstract of their article in page 3386.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti and acid etch the silicon nanoparticles with a hydrofluoric acid and nitric acid solution under conditions effective to produce photoluminescent silicon nanoparticles for the benefit of shifting the luminescent peak at a desired position of the visible spectrum as taught by Seraphin in the abstract of their article in page 3386.

Regarding claims 12 and 13, Botti teaches silicon nanoparticles having an average diameter between 5 – 20 nm in the abstract of the article in page 3396.

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Regarding claims 15 and 30, Seraphin teaches the acid solution comprises about 0.5% to 20% hydrofluoric acid and about 10% to 40% nitric acid in column 1 of page 3387 under the heading "Experimental Apparatus".

Regarding claim 16, Botti in view of Seraphin fails to teach acid solution comprising 3% hydrofluoric acid and 32% nitric acid.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control the concentration of the HF and HNO₃ solution through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) because the size of the particles can be controlled by the oxidation and etching of the oxide by HF. Both of these factors are dependent on the strength of these two acids.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

Regarding claims 22 – 24 and 31 – 33, Seraphin teaches treating the photoluminescent silicon nanoparticles with an oxidizer such as 20 – 40% nitric acid solution under conditions effective to achieve particle surface oxidation in column 1 of page 3387 under the heading "Experimental Apparatus".

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Regarding claims 25 and 34, Botti in view of Seraphin fails to teach oxidizer is 30% nitric acid solution.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control the concentration of the HNO_3 solution through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) because the size of the particles can be controlled by the oxidation of the particles with HNO_3 . Oxidation rate is dependent on the strength of the acid and dipping time.

8. Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Botti, "Photoluminescence From Silicon Nanoparticles Synthesized By Laser – Induced Decomposition Of Silane," J. Appl. Phys., Vol. 88 (6), p 3396 (2000) in view of Seraphin, "Influence Of Nanostructure Size On The Luminescence Behavior Of Silicon Nanoparticles Thin Films," J. Mater. Res., Vol. 12 (12), p 3386 (1997) as applied to claim 1 above, and further in view of Withrow, "Effects Of Hydrogen In The Annealing Environment On Photoluminescence From Si Nanoparticles," J. Appl. Phys., Vol. 86 (1), p 396 (1999).

Botti in view of Seraphin teaches the use of helium as the sheath gas as described earlier in rejecting claim 1, but fails to teach sheath gas comprising hydrogen.

Withrow teaches the role of using hydrogen incorporated in the silicon nanoparticles at high temperature for the benefit of enhancing the photoluminescence yield in Silicon Nanoparticles in the abstract of their article in page 396.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti and use sheath gas comprising hydrogen to incorporate hydrogen in the silicon nanoparticles at high temperature during the pyro CVD synthesis for the benefit of enhancing the photoluminescence yield in Silicon Nanoparticles as taught by Withrow in the abstract of their article in page 396.

9. Claims 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Botti, "Photoluminescence From Silicon Nanoparticles Synthesized By Laser – Induced Decomposition Of Silane," J. Appl. Phys., Vol. 88 (6), p 3396 (2000) in view of Seraphin, "Influence Of Nanostructure Size On The Luminescence Behavior Of Silicon Nanoparticles Thin Films," J. Mater. Res., Vol. 12 (12), p 3386 (1997) as applied to claim 1 above, and further in view of Ehbrehth, "Deposition and Analysis of Carbon and Silicon Clusters Generated by laser – Induced Gas Phase Reaction," Proc. SPIE, p 171 – 172 (1996).

Botti in view of Seraphin fails to teach reacting the silicon precursor in the presence of a photosensitizer comprising sulfur hexafluoride or silicon tetrafluoride.

Ehbrehth teaches the use of SF₆ for the benefit of synthesizing silicon clusters for laser – induced gas phase synthesis in the abstract of the paper.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti and use a photosensitizer comprising sulfur hexafluoride for the benefit of synthesizing silicon clusters for laser – induced gas phase synthesis as taught by Ehbrehth in the abstract of the paper.

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10. Claims 8 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Botti, "Photoluminescence From Silicon Nanoparticles Synthesized By Laser – Induced Decomposition Of Silane," J. Appl. Phys., Vol. 88 (6), p 3396 (2000) in view of Seraphin, "Influence Of Nanostructure Size On The Luminescence Behavior Of Silicon Nanoparticles Thin Films," J. Mater. Res., Vol. 12 (12), p 3386 (1997) as applied to claim 1 above, and further in view of Huiskens, "Light – Emitting Silicon Nanocrystals From laser Pyrolysis", Advanced Materials, Vol. 14 (24), p 1861 (2002) and Zupancic, US 4,613,440.

Botti in view of Seraphin fails to teach collecting the silicon nanoparticles on a filter made of a cellulose nitrate membrane after reacting and before acid etching.

Huiskens teaches using a filter for catching the nanoparticles for the benefit of collecting large quantities of nanoparticles in the abstract of his article. Zupancic teaches the use of semipermeable membrane filter of cellulose nitrate in column 3, lines 19 – 30 for the benefit of utilizing them in a separation process in column 4, line 36.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti and use a semipermeable membrane filter of cellulose nitrate for the benefit of collecting large quantities of nanoparticles in the as taught by Huiskens in the abstract of his article and also for the benefit of utilizing the filter in a separation process as taught by Zupancic in column 4, line 36.

11. Claims 17 – 21 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Botti, "Photoluminescence From Silicon Nanoparticles Synthesized By Laser – Induced Decomposition Of Silane," J. Appl. Phys., Vol. 88 (6), p 3396 (2000) in

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view of Seraphin, "Influence Of Nanostructure Size On The Luminescence Behavior Of Silicon Nanoparticles Thin Films," J. Mater. Res., Vol. 12 (12), p 3386 (1997) as applied to claim 1 above, and further in view of Nayfeh, US 6,585,947.

Regarding claims 17 – 21, Botti in view of Seraphin fails to teach dispersing the nanoparticles in a solvent of methanol, collecting them on a filter after etching and washing after collection.

Nayfeh teaches collecting and dispersing nanoparticles in a solvent of methanol or other solvents before etching, filtering and washing for the benefit separating the nanoparticles of specific size for luminescence in a specific range of the visible spectrum in column 4, lines 35 – 65.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti in view of Seraphin and disperse the nanoparticles in a solvent of methanol, collecting them on a filter after etching and washing after collection for the benefit separating the nanoparticles of specific size for luminescence in a specific range of the visible spectrum as taught by Nayfeh in column 4, lines 35 – 65 and these processes are standard practices in chemical synthesis and treatment of particulate materials in solution.

Regarding claim 26, Botti in view of Seraphin fails to teach isolating the photoluminescent silicon nanoparticles having peak emission in the orange or red spectral region and treating the isolated photoluminescent silicon nanoparticles under conditions effective to induce rapid thermal surface oxidation of the particle surface.

Seraphin teaches treating the isolated photoluminescent silicon nanoparticles under conditions effective to induce rapid thermal surface oxidation of the particle surface in column 1 of page 3387 under the heading "Experimental Apparatus".

Botti in view of Seraphin fails to teach isolating the photoluminescent silicon nanoparticles having peak emission in the orange or red spectral region.

Nayfeh teaches isolating the photoluminescent silicon nanoparticles having peak emission in the orange or red spectral region for the benefit separating the nanoparticles of specific size with a 200nm commercial filter for obtaining luminescent particles in a specific range of the visible spectrum in column 4, lines 35 – 65.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti in view of Seraphin and isolate the photoluminescent silicon nanoparticles having peak emission in the orange or red spectral region and treating the isolated photoluminescent silicon nanoparticles under conditions effective to induce rapid thermal surface oxidation of the particle surface since they are the particles of fairly large size for the benefit separating the nanoparticles of specific size with a 200nm commercial filter for obtaining luminescent particles in a specific range of the visible spectrum as taught by Nayfeh in column 4, lines 35 – 65.

12. Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Botti, "Photoluminescence From Silicon Nanoparticles Synthesized By Laser – Induced Decomposition Of Silane," J. Appl. Phys., Vol. 88 (6), p 3396 (2000) in view of Seraphin, "Influence Of Nanostructure Size On The Luminescence Behavior Of Silicon

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Nanoparticles Thin Films," J. Mater. Res., Vol. 12 (12), p 3386 (1997) in view of Korgel, US 6,846,565.

Botti in view of Seraphin teaches treating photoluminescent silicon nanoparticles under conditions effective to produce photoluminescent silicon nanoparticles having a Si – H terminated surface as was described earlier in rejecting claims 1 – 3, 6, 7, 12 – 16 and 27 – 30. Treatment with HF will leave Si – H terminated surface on silicon nanoparticles. and

Botti in view of Seraphin, however, fails to teach treating the Si-H surface terminated nanoparticles under conditions to achieve particle surface hydrosilylation.

Korgel teaches a method of capping silicon nanoparticles by a hydrosilylation method by reacting the silicon with organic hydrocarbon capping agents in column 8, lines 50 to column 9, line 27 for the benefit of controlling the reactive degradation of the silicon nanoparticles in column 8, lines 8 – 14.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti in view of Seraphin and treat the Si-H surface terminated nanoparticles under conditions to achieve particle surface hydrosilylation for the benefit of controlling the reactive degradation of the silicon nanoparticles as taught by Korgel in column 8, lines 8 – 14.

13. Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Botti, "Photoluminescence From Silicon Nanoparticles Synthesized By Laser – Induced Decomposition Of Silane," J. Appl. Phys., Vol. 88 (6), p 3396 (2000) in view of Seraphin, "Influence Of Nanostructure Size On The Luminescence Behavior Of Silicon

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Nanoparticles Thin Films,” J. Mater. Res., Vol. 12 (12), p 3386 (1997) in view of Zou, “Surface Functionalization Of Si Nanoclusters With Alkoxide and NMR Studies,” Abstract of Paper presented in ACS National meetings, March (2003) and Bocarsly, “Surface – Chemical Control Of Optical Quenching Process At Porous Silicon Interfaces: Generation Of a Stable – Selective Sulfur – Dioxide Sensor,” Abstract of Paper presented in ACS National meetings, March (2000).

Botti in view of Seraphin fails to teach treating photoluminescent silicon nanoparticles under conditions effective to produce photoluminescent silicon nanoparticles having a Si – OH terminated surface and treating the Si – OH surface terminated nanoparticles under conditions to achieve particle surface silanization.

Zou teaches that Si – OH terminated silicon nanoparticles can be made for the benefit of long – term stability in the abstract of their paper.

Bocarsly teaches that Si – OH terminated silicon nanoparticles (due to the reaction in water) can be silanized with silyl derivatives for the benefit of further stabilization of the characteristic photoluminescence properties of silicon nanoparticles in the abstract of the paper.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Botti in view of Seraphin and treat photoluminescent silicon nanoparticles under conditions effective to produce photoluminescent silicon nanoparticles having a Si – OH terminated surface and treat the Si – OH surface terminated nanoparticles under conditions to achieve particle surface silanization for the benefit of long – term stability as taught by Zou in the abstract of their paper and also for

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the benefit of further stabilization of the characteristic photoluminescence properties of silicon nanoparticles as taught by Bocarsly in the abstract of the paper..

Conclusion

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Asok K. Sarkar whose telephone number is 571 272 1970. The examiner can normally be reached on Monday - Friday (8 AM- 5 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William B. Baumeister can be reached on 571 272 1722. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

15. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Asok Kumar Sarkar

Asok K. Sarkar
July 22, 2005

Primary Examiner